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Engineering professor Robert Jahn laid his career on the line to test the power of

PSYCHIC POWERS WHAT ARE THE ODDS?

the mind over machines. He thinks he's onto something.

John McCrone reports

IN THE lobby of the Flamingo Hilton, Las Vegas, slot machines—one armed bandits—stretch in serried ranks to the far horizon. Hanging over the machines nearest the entrance stands a sign stating: "97·4—the hottest slot percentage in town". With characteristic American bluntness, the Flamingo's management tell customers that the machines have been adjusted to cream off "only" 2·6 cents of every dollar they spend.

This promise of steady, if unspectacular, loss is supposed to draw in the punters from the gritty heat of the Las Vegas strip. And attract them it does. So impatient are they to shed their money at the guaranteed rate that they feed adjacent machines with both hands, shovelling in coins and barely waiting for the clacking reels to come to rest.

If ever proof were needed against the existence of telepathy, psychokinesis, precognition or any other form of psychic power, the gambling halls of Las Vegas seem to provide the perfect place to find it. The odds on every game of chance—from the slot machines and crap games to the blackjack and roulette tables—have been fine-tuned to fractions of a per cent. Judging by the faces masked in concentration, it can hardly be said that the gamblers are not exerting every psychic effort to win. And yet still the cash flows into the pockets of the casino owners in an even, predictable stream.

Despite such everyday evidence, people continue to believe in the power of the mind. Public opinion polls commonly find that as many as a quarter of the population are convinced that they personally have experienced premonitions or moments of telepathic understanding. Belief in the psychic seems impossible to

shake. But what if someone could design the perfect laboratory test? A test that could settle the matter once and for all, either revealing believers to be dupes or forcing sceptics finally to start taking mental powers seriously? The dream of such an experiment has led parapsychology—the science of psychic research—to experiments which mirror the very games of chance which have made the gambling industry so profitable.

Roll of a dice

Under tightly-controlled conditions, subjects try to influence the outcome of a random event such as the roll of a dice, the radioactive decay of an atom, the diffraction pattern of a beam of light, the fall of a cascade of polystyrene balls, or the "direction" taken by electrical noise. What is more, some parapsychologists claim to be seeing an anomalous effect. They are reporting a deviation from chance which is vanishingly small—just a tenth of a per cent—but when measured over millions of trials, this faint effect multiplies into a hugely significant distortion of the apparent odds.

The results of these trials have provided inspiration for some apparently wacky research into the possibility of "thought-controlled" household appliances. Dean Radin, a researcher at the University of Nevada, in Las Vegas says: "It may be a small difference, but if we can find a way of amplifying it, we could build thought-controlled switches. Perhaps in fifty years we will be using psychokinesis to open our garage doors or change channels on our TVs." If the research grapevine is to be believed, a laboratory in one of the world's biggest electronics companies already has a team

thinking about these futuristic gadgets.

But before we get carried away by visions of an effortless, thought-driven world, what is the scientific status of micro-psychokinesis—supposed ability of the mind to influence small events.

Psychic experiments with random systems date back to at least the 1930s. But most of the early research relied on dice or mechanical devices which, because of slight imperfections of manufacture, could never be truly random, and which were also rather susceptible to fraud. Reviews of this work showed that the tighter the controls, the less likely an experimenter was to report an effect.

In the 1970s, Helmut Schmidt of the Mind Science Foundation in San Antonio made a major advance with the introduction of experiments that used a Geiger counter to measure radioactive decay. The testers were asked to speed up or slow down the rate of decay as displayed on the Geiger counter without touching the instrument or the radioactive source. Then in the 1980s, Robert Jahn, an engineering professor at Princeton University, New Jersey, began studies using the random white noise generated by an electrical diode.

Demolition job *How do you prove something is random?*
 Jahn's work is currently the most respected of PK studies because of its scale and technical sophistication—although as was made plain when Jahn featured in a recent BBC2 TV series, *Heretic*, his move into parapsychology has horrified Princeton's authorities. When Jahn, a rocket propulsion specialist, went public with his research in 1986, he was demoted from dean of the engineering faculty to an associate professorship and left in no

doubt that he would have been booted right off campus if it were possible.

Even in the safety of his Princeton Engineering Anomalies Research (PEAR) laboratory funded by the McDonnell Foundation and the Fetzer Institute, in the basement of the engineering department, Jahn has had to face a barrage of criticism from former colleagues and other sceptics. Some dismissed his results as being caused by faulty laboratory equipment, others have even suggested that they could be the result of fraud. There is also a constant demand for Jahn to clearly define the mechanism that converts thought to action.

Despite this rough treatment by fellow academics, Jahn—like most parapsychologists—is surprisingly open and helpful when questioned about his research. His first remark is that common-sense examples such as gambling are not a particularly good argument against paranormal powers. Jahn points out that in group situations, such as race courses and roulette games, many people would be willing different outcomes and these are likely to cancel each other out. Then, of course, there are the management's wishes to consider.

Another confounding factor, he believes, is the possibility of "psi-missing" where some people might consistently get the opposite of what they try to will. Finally, the size of the effect being claimed—just a tenth of a per cent—is so small that it could easily be built into the odds on gambling devices like slot machines.

Tossing a coin

Jahn has also gone out of his way to counter criticisms of his scientific technique by running all his experiments under the controlled conditions of the laboratory. His basic experiment, which he has been running for 14 years, is simple. He built a random event generator—roughly, the electronic equivalent of tossing a coin. A thousand times a second, the white noise produced by a diode is sampled and its phase will produce either a positive or a negative value. On average, there should be an equal split. Jahn gets people to sit in front of the generator and will it to produce either more "heads" or "tails". The subjects—or operators, as Jahn calls them—can see how well they are doing from a cumulative line rising or falling on a computer screen.

The most common criticism of this kind of experiment is that either the machine is probably not truly random in performance or that the recording of the results leaves too much scope for mistakes and even plain fraud. Jahn has gone to great lengths to counter these possibilities.

The design of the random event generator does not seem to be in question. Measured over many days and millions of readings, its output has been perfectly well-behaved—even to the point where it throws up the occasional "excursion" into apparently significant deviations from chance. If left to run long enough, a properly random system should sometimes stray quite a way from the mean, and Jahn's generator produced the expected number of such excursions during its calibration trials.

The generator also has safeguards against tampering. Subjects are normally left alone during trials and sceptics have

Jahn has fitted the generator with various warning bells and temperature gauges. But more importantly, the sampling method does not rely on the raw output of the noise diode. Instead, the definition of what counts as a head or tail is alternated with each trial, so a positive signal will be counted as a head on one trial, but a tail the next. This added twist would cancel out any inherent bias that the equipment might develop during the course of an experiment. Switching the polarity criteria a thousand times a second would also seem to rule out any deliberate, or even inadvertent, tampering by subjects.

Controlling conditions

And as yet another precaution, the performance of subjects is measured against three conditions: subjects must move the line up for half the time; down for half the time; and, as a control, they must sit by the box, leaving it to perform on its own. Jahn says it is difficult to think what kind of equipment failure or environmental interference could change its direction as the subject has to switch between each of the three conditions.

The control over recording data seem equally stringent. One complaint against many earlier parapsychology experiments was that subjects could begin and end trials as they wanted. By recording trials that seemed to be going in the desired direction, and aborting sessions once they began to produce a downward turn using the excuse of having a headache or suddenly feeling uninspired, subjects could manipulate an experiment to create a result. But Jahn guarded against such perils by specifying the number of trials to be completed in advance and insisting that all results be recorded in the final database. In addition, the initiation of each session and the logging of results was controlled by computer software. Not only were results automatically dumped onto tape, but the computer printed out a separate paper record and subjects wrote up their scores in the laboratory's logbook.

With an apparently watertight design, Jahn reported his first major batch of results in 1986 after completing a quarter of a million experimental trials (a trial consisting of 200 "coin-flips" in each of the three conditions). This was already several hundred times more data than collected by any other micro-PK

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suggested that its output could be affected by something as crude as it being given a kick, to more subtle effects like waving a magnet near it or even just leaning towards the machine and creating some sort of weak capacitance effect from the static on a subject's clothing.

To guard against such possibilities,

researcher. But Jahn and the small team he assembled kept on going, and by last year Jahn had reached 14 million trials using over 100 different subjects.

In brief, the results he has found are tiny but highly significant. The size of the effect is about 0·1 per cent, meaning that for every thousand electronic tosses, the random event generator is producing about one more head or tail than it should by chance alone. However, while microscopic, the effect is so constant that there is only a 1 in 5000 chance that Jahn's results are a statistical fluke rather than some kind of anomaly.

So it seems like game, set and match to the parapsychologists. An experiment which was designed to meet all the standard criticisms of psychic research has come up with a steady, robust result. Certainly Jahn's work appears to have put sceptics, such as James Alcock of York University, Ontario, and Ray Hyman of the University of Oregon—both members of the self-appointed policing body, the Committee for the Scientific Investigation of Claims of the Paranormal (CSICOP)—on the defensive. Yet a closer look at the detail of Jahn's findings still raises some worrying questions.

Since reporting his early results in 1986, Jahn has extended the scope of his experiments. What he has found is that the anomalous effect appears astonishingly insensitive to changing circumstances. The size of the effect, for example, remains much the same when instead of testing the influence of subjects on a physical process—the random thermal movement of electrons across a transistor junction, for example—Jahn asks them to disturb the output of a pseudo-random source. The pseudo-random number generator is just a repetitive mathematical calculation, so it would seem that the mind is as good at influencing arithmetic as real events.

The size of the effect also appeared constant when Jahn tested subjects with a random mechanical cascade. This device is a pinball machine, looking rather like a giant version of the popular Japanese arcade game, *pachinko*, in which 9000 polystyrene balls are dropped through a grid of nylon pegs, bouncing and skittering to collect in bins at the bottom. In an unbiased system, the balls should end up with a classic Gaussian distribution.

Jahn claims that when subjects sat in front of this three-metre-high "macro-PK" device, they were able to produce slight deviations to the side.

More implausibly still, the effects on all three systems seemed impervious to distance and time. Over the past few years, Jahn has reported the results of large-scale trials in which 30 people attempted

happening is not a mental interference with a physical event but something much more subtle—a distortion of the laws of statistics themselves. Jahn thinks that subjects somehow distort the "probability envelope" of an outcome.

How they are supposed to do so is far from clear. Jahn has written about how such a view ties in with a quantum mechanical view of consciousness in *Margins of Reality*, coauthored with Brenda Dunne, who manages the laboratory. Jahn argues that, like quantum systems, consciousness appears to have both a "particle" and a "wave" aspect. Consciousness is at its most concrete and particle-like when involved in ordinary rational thought, but becomes fluid and wave-like when thinking is creative and holistic. Jahn cites the wave aspect of quantum systems which allows the systems occasionally to penetrate physical barriers—a phenomenon familiar to microelectronics engineers who have seen this effect with quantum tunnelling in which particles can be made to "leap" across insulated junctions. So, by analogy, the mind might be able to reach beyond the brain and have a faint resonant influence on the surrounding world.

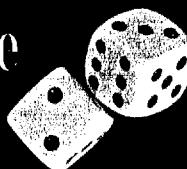
Mumbo jumbo

Sceptics, however, treat such talk as mumbo jumbo. They point out that, for a start, statistics are something that emerge from the behaviour of random processes, not something that creates them. Instead, sceptics see the surprising insensitivity of the claimed PK effect as being rather fishy.

Suspicions have hardened as sceptics have looked more closely at the fine detail of Jahn's results. Attention has focused on the fact that one of the experimental subjects—believed to be a member of the PEAR laboratory staff—is almost single-handedly responsible for the significant results of the studies.

This was noted as long ago as 1985 by a fellow parapsychologist, John Palmer of Durham University, North Carolina, who wrote a report on Jahn's work for the US Army. One subject—known as operator 10—was by far the best performer, and this trend has continued. On the most recently available figures, operator 10 has been involved in only 15 per cent of the 14 million trials but contributed a full half of the total "successes". If this person's figures are taken out of the scoring in the "low intention"

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to influence the devices from as far away as Kenya, New Zealand, England and Russia. Each subject would sit down for an hour at an agreed time and try to alter output according to a prearranged pattern. The distance a subject was from the experiment seemed to have no effect on the end result.

In another batch of trials using the same people, Jahn asked them to make their efforts up to several days before or after the running of the machine. If anything, says Jahn, the effect was slightly stronger under such extreme conditions.

Jahn is not perturbed by such a pattern of results. He says that on the face of it, if psychic powers exist, they should be strongest when subjects are closest to the equipment. Also it seems likely that feedback on success rates and the kind of device being used should have an effect. But Jahn believes that micro-PK is

The luck of the draw

WHILE successful parapsychology experiments grab attention, failures to find a result rarely get any press. But one recent experiment—modelled closely on Robert Jahn's micro-PK studies—is worth mentioning.

Stan Jeffers, a physicist at York University, Ontario, says his curiosity was piqued

when he stumbled upon an old report of Jahn's research. He says Jahn's methodology sounded impressively solid, which inspired him to mount his own parapsychological research. Soon he discovered that CSICOP member, James Alcock, worked at the same university, and this helped when producing a strong experimental design.

Jeffers's idea was to test

people's ability to bend a beam of light and so distort the interference pattern created as it passed through a diffraction slit. Jeffers says the experiment was a straight optical equivalent of Jahn's polystyrene ball cascade, except that because he used photons, subjects were dealing with "billions" of events per second and so he expected any effect to show up quickly.

After testing over 80 people—including self-proclaimed psychics—Jeffers found only chance results.

Jahn himself admits that he expected Jeffers's experiment to work and was puzzled when it did not. Jahn has since lent Jeffers one of his new miniature random noise generators and Jeffers is planning further investigations.

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condition falls to chance while "high intention" scoring drops close to the .05 probability boundary considered weakly significant in scientific results.

Sceptics like Alcock and Hyman say naturally it is a serious concern that staff at PEAR have been acting as guinea pigs in their own experiments. But it becomes positively alarming if one of the staff—with intimate knowledge of the data recording and processing procedures—is making such a huge contribution to the "successful" results.

Adding fuel to the controversy, sceptics have pointed to the strange behaviour of the baseline condition results. Theoretically, the baseline condition should show the same gently wandering pattern as the calibration trials which separately validated the generator's performance, with occasional excursions into areas of apparent significance. Instead, the baseline result has stuck unnaturally close to a zero deviation from chance.

In noting these results, Jahn himself has remarked that what makes the situation even odder is that when the baseline statistics and the high and low scores are all added together, the result is a well-behaved Gaussian distribution. It is almost as if the extra hits found in the high and low scores had been taken from what would otherwise have been outliers of the baseline condition.

Alcock says this is exactly the sort of pattern that might be expected if some sort of data sorting had been going on. Given an effect size of just one in a thousand, it would not take much to distort Jahn's results.

Little of this speculation has been discussed openly by CSICOP members—to do so would be virtually to accuse Jahn's laboratory of fraud, and sceptics admit they have no proof of that. Alcock also stresses that Jahn is widely respected and such alterations need not be deliberate, they could happen as the result of honest mix-ups.

Jahn, however, says he is well aware there has been a whispering campaign and he welcomes the chance to put the record straight. With candour, Jahn

says no experimental design can ever rule out fraud. But he believes that the recording procedures at PEAR are unusually tight and any fiddling with results would have to be systematic because it would have to include the laboratory's computer database, the print-outs and subjects' entries in the logbook. Jahn adds that sceptics have had a long-standing invitation to check his work first-hand and the few that have dropped by seem to have left relatively impressed.

Into the unknown

Jahn admits that operator 10—whom he insists must remain anonymous—has been responsible for a large proportion of the significant findings. But he makes two points. First, at least four or five other of the 100 subjects show a more powerful effect than operator 10. What is different is that they have been involved in far fewer trials. Jahn says if these better performers had been able to do as many runs as operator 10—and if the strength of their effects persisted—then operator 10's results would have dropped away into the background.

His second point is that when the contributions of all the operators are plotted, they form a smooth continuum. Just as there are a few high performers like operator 10 at one end of the spectrum, so there are an equal number

of poor performers—even psi-missers—at the other end who drag the overall numbers down. With over 100 subjects, statistically speaking there would have to be a few high-end scorers like operator 10, so no sinister conclusions should be drawn from that fact alone.

As to the "too perfect" baseline, Jahn says this fits in neatly with his argument that what subjects are doing is bending statistics rather than having a direct influence on physical events. It seems that, in the short term, subjects can pull the scoring in one direction. But this has to be balanced by a shortfall in later extreme scores.

However, in the end, says Jahn, sceptics will always be able to dismiss positive results from a parapsychology experiment. Suspicions of fraud, faulty machinery or plain mistaken recording of data can never be completely countered. Jahn says the only way forward is to have the same experiment replicated by other laboratories. This is why he has recently built a cheap, solid-state version of his random event generator and over the past year he has been farming them out to other interested investigators.

Yet even replications may not be the answer, given the strength of entrenched views. Hardened sceptics are just as likely to find reasons to suspect a successful replication. And, of course, the same doubts work the other way. If a scientist produces negative results (see Box), then the parapsychologists may be the ones to start talking about incompetence and faulty procedures.

Recent experience suggests there may never be a simple, conclusive test of the existence of psychic powers.

However, Jahn's work does seem to narrow the boundaries somewhat, for if such abilities exists, then their effects appear microscopically small. They also seem quite bizarrely resistant to the constraints of time, place and logic. Knowing what science is not looking for, at least is knowing something.

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